

Attachment for USID: 120 GeV Primary Beam Through MCenter Secondary

Description of Proposed Activity

We propose to demonstrate the capability of the MCenter Secondary beamline to transport 120 GeV beam into the MC7 enclosure.

Preliminary work includes:

- The areas mentioned are presently assessed for 64 GeV beam. Working with Radiation Safety we will use a scaling law to estimate the 120 GeV intensity which results in the same dose as the present 64 GeV intensity. That is, we will estimate the reduction in intensity necessary to offset the increase in energy while keeping the dose constant.

The estimated required reduction is approximately 2×10^{-3} .

- Using data from the 2004 120 GeV run for MCSecondary, we will document the achieved attenuation factor. There have been no changes the primary beamline since 2004. Therefore, the attenuation factor should remain unchanged.

The documented attenuation factor ranges from 2×10^{-6} to 5×10^{-6} – several orders of magnitude greater than required.

- Verify that MC6D is capable of running at the 120 GeV current.

This test was successfully completed on October 6, 2020.

- Completed work is documented in “Preparing MCenter Secondary for 120 GeV Beam”, Beams-doc-8615.

The ability to transport 120 GeV beam in the MC7 enclosure will be demonstrated using a staged approach:

1. Radiation Safety will issue an operating note allowing the insertion of the pinhole collimator into the beamline. This will allow one to measure the primary intensity downstream of the pinhole collimator and immediately before the primary target (MC6TGT). No additional changes to the beamline will be made during this time. The current interlock on MC6D, limiting the energy to 64 GeV, will remain in place; inserting the MC2PIN will reduce the intensity of beam transported into MC7. Radiological issues associated with inserting the pinhole collimator are addressed below.
2. Once it has been demonstrated that MC2PIN reduces the primary beam to an acceptable level, Radiation Safety will rescind the above operating note and issue a second operating note. The second operating note will specify that the pinhole collimator is inserted in the beamline, the primary target (MC6TGT) is removed, the current interlock on MC6D is bypassed, and MC6D is set to the 120 GeV operating current. The beam will be transported into enclosure MC7 where

it is absorbed by the NOvA production target and surrounding shielding. Successful transport will be demonstrated by recording beam profiles on the MC7 profile monitors.

Final work will include:

- Rescind the second operating note, restore the current interlock to MC6D, reinstall MCTGT, and remove MC2PIN from the beamline. At this point, the test is concluded.

Due to the staged approach of this demonstration, we do not foresee an increase in hazard. Issuing operating notes will serve as breakpoints where the plan may be assessed. Reducing the intensity of the beam to counter the increase in energy will mitigate any radiological hazards. This demonstration will constitute a proof-of-principle test; it is a temporary mode. The results will inform us of the work required to make this mode turn-key (as in MTest).

Justification of USI Determination Criteria

- Could the change significantly increase the probability of occurrence of an accident previously evaluated in the SAD?

No. The method of transporting beam through MCenter Primary and Secondary is unchanged. We will continue to use slow extraction and conventional magnets.

The Shielding Assessment for MCenter primary relies on passive shielding. Introducing MC2PIN does not affect the shielding.

The Shielding Assessment for MCenter Secondary relies on passive shielding and interlocked detectors. Introducing MC2PIN affects neither the shielding nor the detectors.

The thermal protection of MC6D will remain unchanged. Additionally, MC6D will be proven to safely operate at 120 GeV during the preliminary work.

- Could the change significantly increase the consequence of an accident previously evaluated in the SAD?

No. Inserting MC2PIN will not increase the consequence of an accident in the primary beamline. As per the SAD, MCenter Primary can safely transport $1.02E12$ per hour at 120 GeV; assuming a 60 second supercycle, this equates to $1.7E10$. The accident condition assumes the entire beam is lost in a single location for one hour. This rate will not be exceeded. The introduction of the MC2 pinhole collimator (MC2PIN) will introduce a new loss point which is accounted for in the Shielding Assessment.

Inserting MC2PIN will not increase the consequence of an accident in the secondary beamline. By implementing the first operating note, MC2PIN will decrease the intensity of secondary beam transported to MC7. The second operating note will not be implemented unless it is shown that MC2PIN reduces the primary intensity to a safe level. The radiation safety system, which protects MCenter secondary, will not be changed.

Removing MC6TGT has not affect on the primary beamline.

Removing MC6TGT will not increase the consequence of an accident in the secondary beamline. The second operating note will not be implemented unless it is shown that MC2PIN reduces the primary intensity to a safe level. Additionally, the radiation safety system, which protects MCenter secondary, will not be changed.

Bypassing the 64 GeV interlock on MC6D will not increase the consequence of an accident in the primary beamline (this device is located in the secondary beamline).

Bypassing the 64 GeV interlock on MC6D will not increase the consequence of an accident in the secondary beamline. The second operating note will not be implemented unless it is shown that MC2PIN reduces the primary intensity to a safe level. Additionally, the radiation safety system, which protects MCenter secondary, will not be changed.

Bypassing the 64 GeV interlock on MC6D will allow MC6D to be run at a higher electrical current. The fail-safe thermal interlock system will continue to protect the magnets and power supply from overheating. The preliminary work will demonstrate that MC6D can safely and reliably operate at the 120 GeV electrical current. In the event of a failure, MC6D will not be energized, inhibiting beam transport beyond enclosure MC6. This scenario is accounted for in the Shielding Assessment; the decreased primary intensity, due to MC2PIN, reduces the consequence of this accident.

- Could the change significantly increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the SAD?

No. Inserting MC2PIN, removing the target, or running MC6D, will not affect the integrity of the radiation safety system. Additionally, passive shielding will not be changed.

Bypassing the 64 GeV interlock on the momentum selection dipoles in the secondary beamline does not increase the probability of a malfunction of the thermal interlocks.

- Could the change significantly increase the consequence of a malfunction of equipment important to safety previously evaluated in the SAD?

No. The radiation safety system, which is fail-safe, will remain unchanged. The radiation safety system inhibits beam before transport to MC2PIN.

The thermal interlock on MC6D is fail-safe. If the interlock were to fail, beam would not be transported into MC7.

- Could the change create the possibility of a different type of accident than previously evaluated in the SAD that would have a potentially significant safety consequence?

No. The hazards listed in SAD II-15.2 (Inventory of Hazards) remain unchanged. The accelerator-specific hazards also remain unchanged.

- Could the change increase the possibility of a different type of malfunction of equipment important to safety than any previously evaluated in the SAD?

No. The operation of the safety system is independent of the type of particle transported. Similarly, the thermal interlock on MC6D depends only on the electrical current.